

Evaluation of Automotive Grade Ceramic and Tantalum Chip Capacitors for Space Applications

Michael Sampson, NASA Goddard Space Flight Center

michael.j.sampson@nasa.gov

Jay Brusse, Arctic Slope Regional Corporation Aerospace and Defense (ASRC AS&D)

jay.a.brusse@nasa.gov

Automotive grade multilayer ceramic chip capacitors (MLCC) and tantalum (Ta) chip capacitors are available at lower cost with smaller physical sizes and higher volumetric efficiencies (capacitance per volume) compared to military/space grade capacitors. Designers of high reliability aerospace and military systems would like to take advantage of these attributes of automotive grade chip capacitors while maintaining the high standards for long-term reliable operation they are accustomed to when selecting military qualified established reliability (MIL-ER) MLCC (e.g., MIL-PRF-55681) and tantalum chip capacitors (MIL-PRF-55365).

The objectives for this evaluation were to assess the long-term performance of off-the-shelf automotive grade MLCC and Ta chip capacitors having small case size and high volumetric efficiency not directly available in military/space grade. Eight (8) MLCC lots comprised of size 0402 and 0805 X7R dielectric from four (4) manufacturers and two (2) lots of case size D manganese dioxide (MnO₂) cathode Ta chip capacitors from 1 manufacturer were evaluated. The evaluation consisted of construction analysis, basic electrical parameter characterization, extended long-term life testing and some accelerated stress testing. Tests and acceptance criteria were based upon manufacturer datasheets and the Automotive Electronics Council's AEC Q-200 qualification specification for passive electronic components.

This evaluation found that the long-term life performance of automotive grade MLCCs and Ta chip capacitors is generally within performance specification limits and potentially suitable for space applications. Construction analyses found that some manufacturers may substitute alternate constructions (e.g., MLCCs with flexible terminations) to that which was procured citing their right to provide product they consider to be "same or better than" offerings without notification. For end users that independently qualify technologies for their own applications via periodic lot evaluations such substitutions have the potential to nullify the applicability of previous qualifications.